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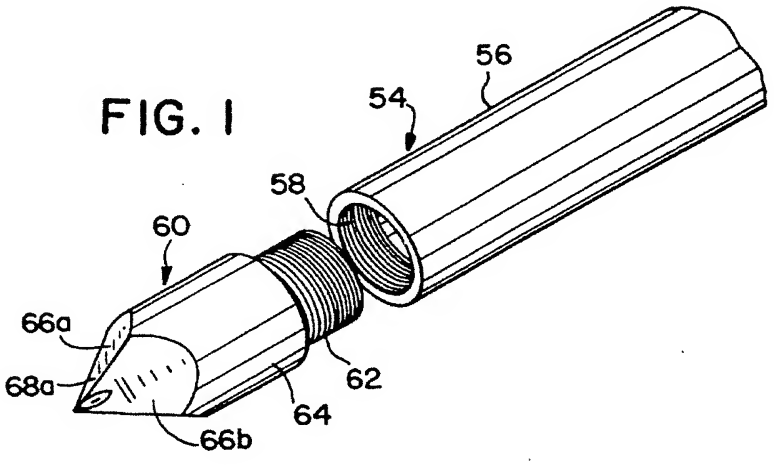
(54) Instrument for penetrating body tissue.

(57) An instrument (54) for the direct penetration of body tissue comprises an elongated rigid hollow shaft (56). A point (60) at the distal end of the shaft (56) is shaped to penetrate body tissue, to create an opening therein and to enlarge the opening as the point (60) is advacend into the body tissue. The distal end portion (70) of the point (60) is capable of transmitting images received back from the surgical site in advance of and laterally of the point (60). The point (60) has a cutting element (68a-68d) to enable the point (60) to pierce and cut the tissue. In the hollow shaft (56) lighting means and light image receiving means are provided.

FIG. 1



EP 0 664 992 A1

FIELD OF THE INVENTION

The invention relates to an instrument for the viewing and penetration of body tissue.

BACKGROUND OF THE INVENTION

Instruments of this type serve particularly as trocars to create an artificial access to body cavities or organs, which do not possess any natural communicating passage with the exterior. The instrument has a point, which serves to pierce the body tissue and to widen the perforation opening and, after removal of the trocar, represents an artificial access to the body cavity, the said access through which endoscopes, instruments, and the like can be introduced into the interior of the body.

The insertion of the trocar, even with the advantageous selection of an injection site, entails the risk of damaging blood vessels in subcutaneous fatty tissue, in fascia, and in the peritoneum ("abdominal membrane"), thus vessels in the abdominal wall. There is the further risk after penetration of the abdominal wall that the vessels in the abdominal area (abdominal cavity) and organs in the abdominal area, such as the large intestine, small intestine, omentum majus (greater omentum), and retroperitoneally located vessels and structures can be damaged. Especially at risk for damage are the small intestine and the omentum majus, if adhesions and concretions with the anterior abdominal wall are present, so that during penetration of the abdominal wall, structures adhering to the said wall may be pierced at the same time before the trocar enters the free abdominal cavity. To reduce the risk of damage, particularly to the intestine and omentum majus, a hollow needle can be passed through the abdominal wall first while the abdominal wall is lifted, to introduce gas into the abdominal cavity and to distance the abdominal wall from the underlying omentum majus and intestine for the subsequent insertion of the trocar. In that case as well, however, there is a residual risk of damage during the insertion of the hollow needle and the trocar.

DESCRIPTION OF THE RELATED ART

EP 0 484 725 A1 discloses an instrument for the penetration of body tissue which reduces as much as possible the risk of damage to vessels, organs, and the like via improved optic control during insertion.

This instrument has a hollow shaft. The point or at least the distal end portion of the point is made as a window from a suitable transparent material, e.g., from glass, quartz glass, Plexiglas, or the like. An optic is run through the hollow shaft to the point, e.g., an optic with glass fiber-optic light guide, as is used in endoscopes. Furthermore, a lighting unit is run in the hollow shaft to the point. The lighting unit can be integrated into the optic in that fiber-optic fibers employed for producing illumination are placed in the tract of the optic. Likewise it is possible to run the illumination separately from the optic through the shaft to the point or also to combine lighting units integrated in the optic with additional separately introduced lighting units. The optic ends at an axial distance behind the summit of the point, so that the entire surface area of the conical window can be illuminated by the optic and observed. The operator thus has a view during the advance of the instrument of the structures to be penetrated and lying in Front of the instrument point. The operator can thus recognize blood vessels, For example, before these are struck by the point of the instrument, and avoid the said vessels. In particular, the important step of the penetration of the peritoneum can proceed within view. The semitransparent peritoneum almost permits a look into the abdominal cavity before total penetration, so that the underlying omentum majus, intestines, and vascular structures in the peritoneum are discernable and damage thereto can be avoided. In addition, during the advance of the instrument, the operator can observe structures penetrated by the point and passing laterally by the surface area of the window, and thus obtains a feeling for the penetration of the point and for the rate of advance.

SUMMARY OF THE INVENTION

The invention has as its object the provision of an instrument for the penetration of body tissue under optic control which reduces the force necessary to advance the instrument during the penetration of tissue.

According to the invention, the point comprises or is provided with a cutting element, especially with one or more sets of surfaces which converge to a line, i. e., a linear edge which is to incise, for example, the abdominal wall, and thereby aid in penetration. The penetration point may be opaque with one or more transparent windows for permitting the passage of light and for receiving an image of tissue, etc. adjacent and in advance of the point. The converging surfaces do not extend beyond the distal end of the point, the distal end thereof being at or rearwardly of the transparent window. The converging surfaces may form the exterior surfaces of the point. In another embodiment, the point comprises a transparent hollow cone and one or more blade members are inserted in the point, having surfaces converging to a linear edge; the linear edge is coplanar with the axis of the shaft

and the conical point. These members do not extend beyond the apex of the point, in order that there may be viewed the tissue, abdominal wall, etc., adjacent and in advance of the instrument before the instrument is advanced, with the assistance of the linear edges, so that viewing of tissue, abdominal wall, etc. is made possible prior to penetration and the making of an incision in each part of the tissue or abdominal wall. Consequently, the surgeon is able to see tissue prior to engagement, penetration or cutting thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail below on the basis of embodiments presented in the figures. Shown are:

Fig. 1 is an exploded perspective view of an instrument for penetration of body tissue in accordance with the present invention;

Fig. 2 is an elevational view of the point shown in Fig. 1 ;

Fig. 3 is an elevational view taken on the line III-III of Fig. 2;

Fig. 4 is a view taken on the line IV-IV of Fig. 3;

Fig. 5 is a cross-sectional view taken on the line V-V of Fig. 3 and showing a fiberoptic bundle;

Fig. 6 is an exploded perspective view of another embodiment of an instrument for penetration of body tissue in accordance with the present invention;

Fig. 7 is an elevational view of the point shown in Fig. 6;

Fig. 8 is an elevational view of an alternate embodiment of a point;

Fig. 9 is an elevational view taken on the line IX-IX of Fig. 7;

Fig. 10 is a view taken on the line X-X of Fig. 7;

Fig. 11 is a cross-sectional view taken on the line XI-XI of Fig. 9, together with an optical fiber bundle;

Fig. 12 is an enlarged view taken on the line XII-XII of Fig.11;

Fig. 13a is an elevational view of the instrument of Fig. 6 in contact with the surface of a body;

Figs. 13b and 13c illustrate successive positions in the penetration of a body with the instrument of Fig. 6 .

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In Fig. 1 there is shown an embodiment of a penetration instrument 54 comprising a rigid linear hollow cylindrical shaft 56 and a point 60. The shaft 56 is internally threaded as shown at 58, and the point 60 has a threaded extension 62 for engagement with the threads 58. The shaft 56 and point 60 may be joined in a manner other than that shown, and may be made of a single piece of material. The point 60 is hollow and on the exterior has a cylindrical portion 64 which is adjacent the shaft 56, as when the instrument 54 is assembled, and has substantially the same outer diameter as the shaft 56. Opposite the proximal end of point 60 there is a distal end which is shaped to penetrate body tissue, to create an opening therein and to enlarge the opening as the point 60 is advanced by the application of force to the shaft 56. As will be appreciated, the distal end of the point 60 is forward of the proximal end thereof, and forward of the shaft 56. At the distal end thereof, forwardly of the cylindrical portion 64, there are preferably four planar surfaces 66a, 66b, 66c and 66d. These exterior surfaces of point 60 are inclined towards the distal end of point 60, so that point 60 enlarges in transverse extent from the distal end towards the proximal end. Each two adjacent surfaces 66a, 66b, 66c and 66d form a set of surfaces which converges to a linear edge 68a, 68b, 68c, and 68d, as shown in Fig. 4. The linear edges preferably are coplanar with the axis of the instrument 54.

Referring now to Fig. 5, there is shown the point 60 and the surfaces 66b and 66c. The point 60 is opaque, and has an opening through the surfaces 66b and 66c at the distal end thereof; in these openings, there is a transparent window 70, although two separate window elements may be provided. The window 70 may comprise a single or two plastic elements, and may have an external curvature to provide a lens. The point 60 is imperforate, the window 70 closing the opening(s) therein.

Optical elements may be provided within the instrument 54 to emit light to be passed through the window 70, the light being reflected from tissue, organ, etc., and passing through the window 70 and providing an image which is viewed by an optical viewing system. The optical viewing systems may comprise, for example, separate optical fibers, or as shown in Fig. 5, may comprise a fiberoptic bundle 72 containing both light transmitting and light receiving optical fibers; also relay lenses may be used instead of optical fibers.

Referring now to Fig. 6 , a further embodiment of an instrument in accordance with the invention is shown, the penetration instrument 74 comprising a linearly extending hollow rigid shaft 76 of circular configuration, and having a threaded extension 78. The point 80 is imperforate, of transparent material, and has internal threads 82 and has a cylindrical portion 84 at its proximal end of the same diameter as the shaft 76. Forwardly of the cylindrical portion 84, the point 80 preferably has a right circular conical distal end portion 86 which converges towards the distal end 90 thereof, which is preferably

perpendicular to end portion 86 as shown, but could be at a different angle, with some reduction in the image acquired.

As shown in Fig. 7, there are provided a pair of thin blade members 88a and 88b having the bases thereof embedded in the conical distal end portion 86. The forward or distal ends of the blade members 88a and 88b terminate in a plane which passes through the truncated end 90 of the conical portion 86 of point 80.

As shown in the embodiment of Fig. 8, in the conical terminal portion 86a of point 80a, there are provided thin blade members 88c and 88d; the forward or distal ends of these members are rearwardly of the truncated end 90a of the conical portion 86a. Consequently, it will be seen that in the embodiments of Figs. 7 and 8 ,the thin blade members are at or rearwardly of the distal end of the point 80, so as to enable the surgeon to see tissue or organ prior to the moving of the instrument in a manner to penetrate or cut the tissue or organ. Hence, the surgeon is enabled to view the tissue or organ in advance of the instrument prior to effecting penetration or cutting thereof.

Fig. 9 and Fig. 10 are other views of the point 80, and as will be seen therein, the blade members 88a and 88b are coplanar with the axis of the point 80, and with the axis of the shaft 76.

Referring now to Fig. 11, there is shown the point 80, including the conical portion 86, with the blade elements 88a and 88b having the bases thereof embedded in the conical portion 86. The truncated end 90 of the conical portion 86 is also shown, which together with the material of the point 80 which is behind it, functions as a window lying on the axis of the point 80, for viewing of tissue or organ directly ahead of the point 80. As is apparent from Fig. 11, the blade members 88a and 88b have their forward or distal ends substantially in the plane of the truncated planar end 90. The distal end of conical portion 86 may terminate in a conical apex; blade members are at or rearwardly of it.

In Fig.12 , there is shown the truncated end 90, the conical portion 86, and the blade elements 88a and 88b; these blade elements contain converging surfaces 88e and 88f, which meet or join at a linear edge 88g, which is the cutting edge of the blade element 88a, 88b.

Referring now to Figs. 13a, 13b and 13c the instrument 74 will be seen in successive stages of penetration of a tissue or organ. Initially, there will be obtained a view of the upper surface of the body to be penetrated before penetration begins. As penetration proceeds, as shown in Figs. 13b and 13c the tissue or organ is cut or severed, and the surgeon will be able to view an image of the portion of the body being penetrated, through utilization of optical lighting and viewing systems (now shown), and will be able to view tissue or organ adjoining the surface of the conical portion 86. Thus, when the instrument 74 enters into each separate layer of tissue or different element of the body, a view thereof will be obtained prior to the actual penetration or cutting of that layer or element.

The utilization of a penetrating point, of tapering, preferably conical configuration, together with linear edges, which cut tissue or organ, enables the instrument to penetrate tissue or organs with minimal, readily controlled force. For example, with the embodiments of Figs. 6-12 , there is only required a force of about 4-8 lb to advance the instrument.

The claims and specification describe the invention presented, and the terms that are employed in the claims draw their meaning from the use of such terms in the specification. Some terms employed in the prior art may be broader in meaning than specifically employed herein. Whenever there is a question between the broader definition of such term as used in the prior art and the more specific use of the term herein, the more specific meaning is meant.

Claims

1. An instrument for the direct penetration of body tissue comprising:
   - an elongated rigid hollow shaft having a distal end;
   - a point at said distal end of said shaft shaped to penetrate body tissue to create an opening therein and to enlarge the opening as the point is advacend into the body tissue by said shaft;
   - at least the distal end portion of said point being capable of transmitting images received back from the surgical site in advance of and laterally of said point;
   - the point having a cutting element to enable said point to pierce and cut tissue; and
   - said hollow shaft being capable of containing a lighting means and a light image receiving means to cooperate with said distal end portion of said point.

2. The instrument of claim 1, wherein said cutting element does not extend beyond said point.

3. The instrument of claim 1 or 2, wherein at least the distal end portion of said point or a portion of said distal end portion is transparent to enable the transmission of light and the image of tissue.

4. The instrument of claim 1, wherein said cutting element is provided by at least one set of surfaces converging to a linear edge having one part thereof closer to the distal end portion of said point than another part thereof, said surfaces having distal ends not beyond the distal end of said point.

5. The instrument of claim 1, wherein said point has a tapered distal end portion.

6. The instrument of claim 4, wherein said point has an axis and said at least one linear edge is coplanar with said axis.

7. The instrument of claims 5 and 6, wherein said point has at least three planar exterior surfaces, each two said surfaces converging to a linear edge, and each of at least two of said planar surfaces has a transparent window at its distal end portion.

8. The instrument of claims 4 and 5, wherein said linear edge is straight and substantially parallel to said tapered distal end portion.

9. The instrument of claim 4, wherein said set of surfaces has at least in part surfaces of a member extending outwardly from said point.

10. The instrument of claim 9, wherein one blade member or at least two circumferentially spaced blade members extend outwardly from said distal end portion of said point comprising said set of surfaces and said linear edge.

11. The instrument of claim 10, wherein said distal end portion of said point is conical.

12. The instrument of claim 11, wherein said distal end portion is conical truncated and said blade members do not extend beyond the planar distal end face of said truncated end portion.

13. The instrument of claim 10, wherein said blade member has a base portion opposite said linear edge embedded in said point.

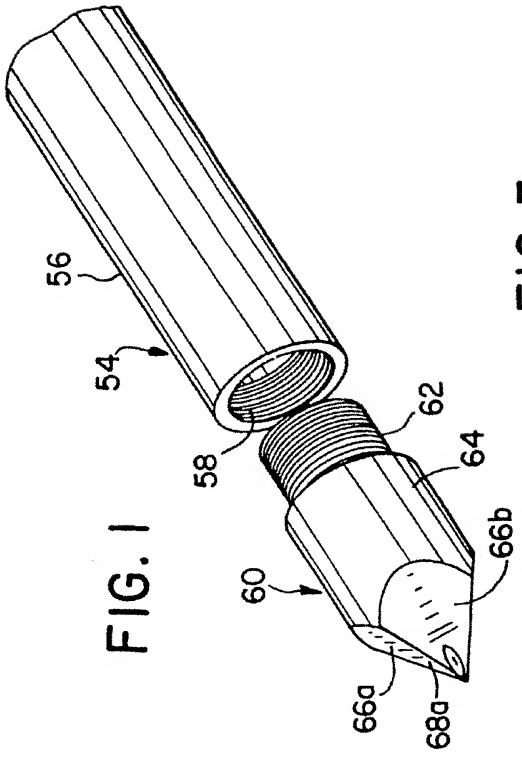


FIG. 1

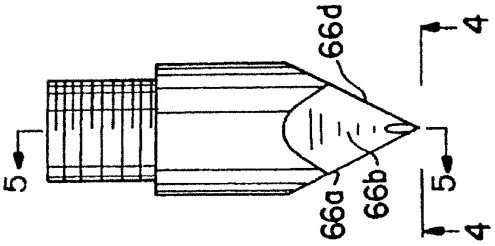


FIG. 3

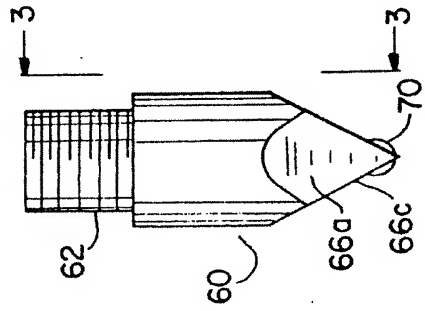


FIG. 2

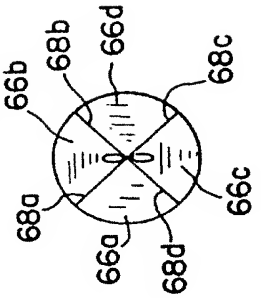


FIG. 4

FIG. 5

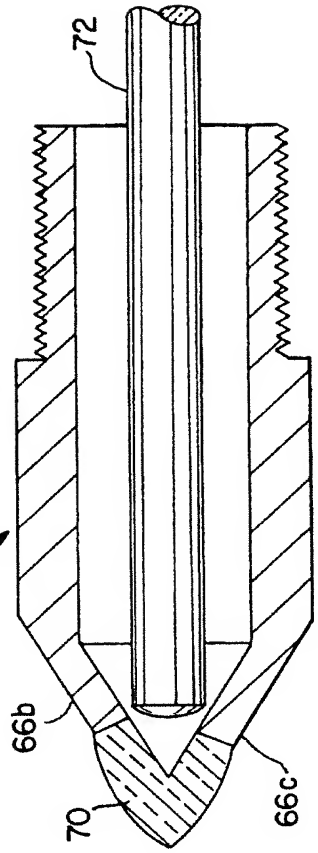
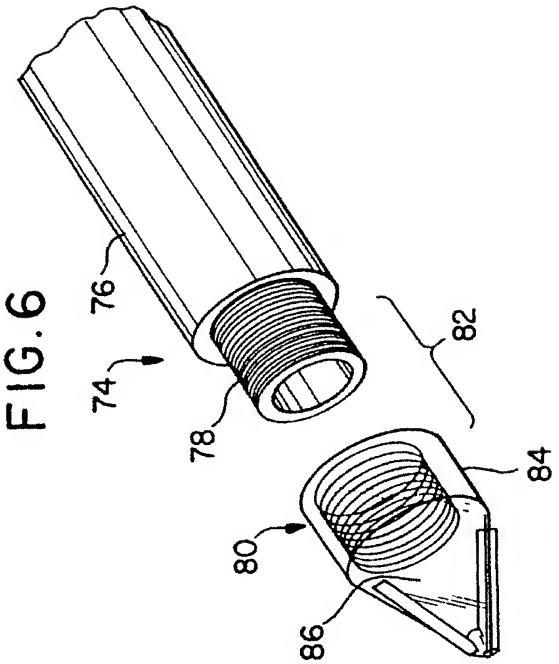


FIG. 6



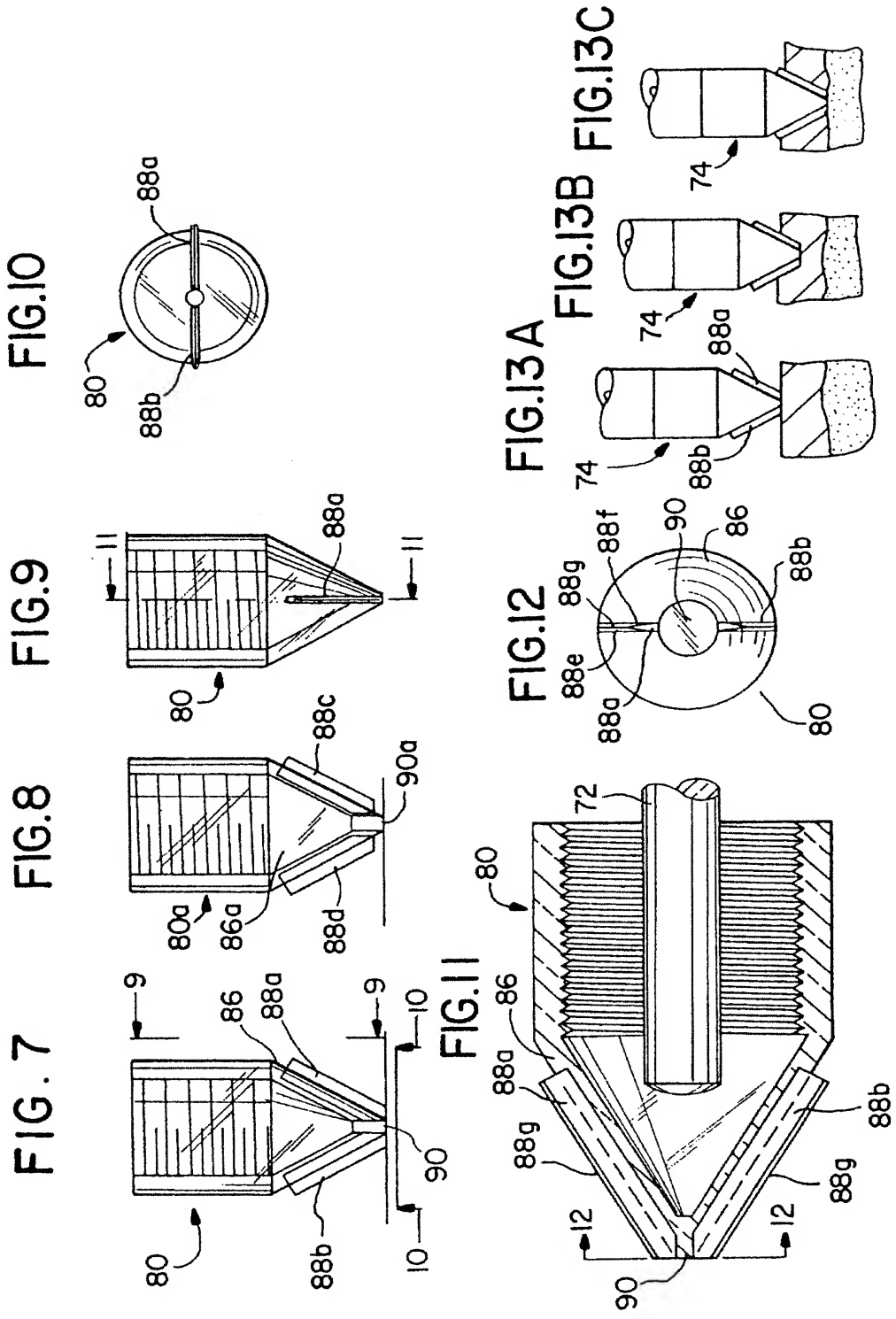


FIG. 7
9
9
86
88a
10
10
90
80
88b
FIG.8
88c
90a
80a
86a
88d
FIG.9
11
11
88a
80
FIG.10
88a
80
88b
FIG.11
72
80
86
88a
88g
88b
88g
12
12
90
FIG.12
88f
90
86
88g
88b
88e
88a
80
FIG.13A
74
88b
FIG.13B
74
88a
FIG.13C
74

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EUROPEAN SEARCH REPORT

Application Number EP 95100884.6

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.6)
D,Y	EP - A - 0 484 725 (RIEK et al.) * Fig. 1-6; abstract; column 5, line 41 - column 8, line 28 *	1-6,8	A 61 B 17/34
Y	DE - A - 4 133 073 (EFFNER GMBH) * Totality *	1,2, 4-6,8	
Y	DE - A - 2 929 233 (MEDTRONIC INC.) * Fig. 3,4; page 16, last paragraph - page 17, line 15 *	1-6,8	
A	DE - A - 2 922 239 (OLYMPUS OPT.) * Totality *	1	
A	APPLIED OPTICS, vol. 24, no. 19, October 01, 1985 G.J. LIESE et al. "Fiber - optic stylet for needle tip localisation" pages 3125-3126 * Fig. 1 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.6) A 61 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	10-04-1995	LUDWIG

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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